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RESEARCH REPORT

ARE IMPORTANCE WEIGHTS SENSITIVE TO THE RANGE
OF ALTERNATIVES IN MULTIATTRIBUTE UTILITY
MEASUREMENT?

WILLIAM F. GABRIELLI, JR.
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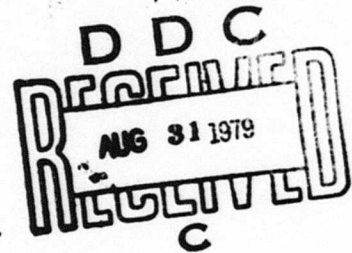
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SUMMARY

Scaling factors in multiattribute utility measurement can either be assessed directly as importance weights or indirectly by indifference judgments. Critics of the importance weight interpretation of scaling factors argue that importance weights are not sensitive to ranges of alternatives and thus cannot be used to match standardized single attribute utility functions. To examine the range sensitivity of importance weight judgments two experiments were designed. In the first experiment college students gave relative importance weight judgments for a number of attributes when evaluating apartments and liquified natural gas plant locations. After the initial importance weight assessments the range of alternatives in one attribute was changed and subjects reassessed their weights. Although subjects were explicitly instructed to take ranges into account when making these judgments, they were unable to adjust their weights appropriately. To magnify possible range effects a second experiment examined a very simple two attribute car evaluation problem. Subjects were asked directly if weights should change after the range in one attribute was doubled. Most subjects indicated that there should be no change. The results of these experiments suggest that subjects have plausible ranges in mind when assessing importance weights and that they are unwilling to change weights after relatively spurious changes in the alternative set.

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Introduction

Multiattribute Utility Theory (MAUT) forms a class of models and scaling procedures for evaluating complex multidimensional alternatives, such as apartments, industrial sites, or social programs. The procedure involves three steps. First is the identification of the possible alternative set. The second step involves the construction of utility functions to evaluate each alternative with respect to each attribute. Finally these single attribute utility functions are combined by an appropriate aggregation rule. The best known aggregation rule is the additive model (see Keeney and Raiffa, 1976; and Edwards, 1977). According to the additive model, single attribute utility functions (u_i) are multiplied by a weight (w_i) and additively combined:

$$u(x) = \sum_{i=1}^n w_i u_i(x_i) \quad (1)$$

where x is an alternative under evaluation and x_i is the level of that alternative on attribute i . Decision analysts usually standardize single attribute utility functions to range between 0 (worst level) and 100 (best level); and normalize weights to sum to one.

In riskless applications of this model, the utility functions reflect the value (or worth) differences within an attribute. If, for example, $u_i(x_i) = 50$, then the worth of x_i is halfway between the best and the worst level in attribute i . The weighting factors w_i match utilities across attributes. Such a match is necessary since not all attributes contribute equally to overall worth.

Consider, for example, the attributes "rent" and "distance from work" in an apartment evaluation problem. Assume that for you a rent decrease from \$300 to \$280 is just as valuable as a distance decrease from 15 to 5 miles. Further assume that the single dimension utility functions are standardized so that the \$20 rent decrease corresponds to a gain of 10 utility points (out of 100 available) while the 10 mile distance decrease corresponds to a gain of 50 points. To make up for this distortion of single attribute utilities, the attribute "rent" has to be weighted five times more than the attribute "distance." Weights thus spell out how much a utility unit in one attribute contributes to overall worth relative to a unit in another attribute.

This interpretation as relative scaling factors makes weights directly dependent on the relatively arbitrary choice of a unit of single attribute utility functions, and, in particular, on the choice of attribute ranges. If, for example, in the above apartment evaluation problem 15 and 5 miles had been the worst and the best level of the attribute "distance", the utility difference would have been 100 rather than 50 and the weight of "rent" should have been 10 times larger than the weight of "distance."

Procedures to construct additive multiattribute utility functions should therefore reflect this sensitivity to choices of units and ranges. Classical indifference methods such as standard sequences (see Krantz, Luce, Suppes and Tversky, 1971) handle this sensitivity by matching units of single attribute utility functions directly in the constructive process. The results of standard sequence

procedures are properly matched utility functions f_i which need no further weighting (and, of course, do not range between 0 and 100). However, such indifference methods involve hypothetical trade-off questions which are sometimes complex, often difficult to understand, and seldom realistic.

The simpler and more intuitively understandable magnitude estimation techniques, on the other hand, may suffer from an insensitivity to the choice of units and ranges. Edwards' SMART procedure (1977) is the best known example of such magnitude estimation techniques. In this procedure single attribute utilities are scaled from 0 to 100, where the endpoints represent the best and worst available alternatives. Judging the relative importance of one attribute over another provides numerical assessment of weights. The range sensitivity of the numerical judgments of "relative importance" is, however, not at all obvious. In fact, the meaning of "importance" suggests some degree of situational invariance, as in statements such as "money is always the most important consideration." Sophisticated applications of SMART try to take this problem into account by making ranges explicit in the importance weight assessment. For example, in so called "swing weight" assessment judges state how much more important a step from the worst to the best alternative in attribute i is relative to a step from the worst to the best alternative in attribute j . Obviously such refinements intend to make the importance weight assessment range sensitive.

Knowing that some ambiguity surrounds the notion of importance

weighting, the present study asked whether subjects are range sensitive in the SMART weighting techniques. The normative rules for changing the weight as a function of the range change are explored. The description of two experiments which tested the range sensitivity of the SMART weighting technique is also included. In the first experiment, subjects applied the full SMART procedure in an apartment selection problem, and in the siting of a liquified natural gas plant. The subjects then repeated the evaluations with a different range on one attribute of each problem. The second experiment attempted to magnify the range sensitivity in a simple two attribute car evaluation problem which required subjects to explicitly change weights.

How Should Weights Be Changed If the Range Changes?

The introductory apartment evaluation example clearly shows that weights are dependent on the choice of units and ranges of single attribute utility functions. Restandardizing single dimension utility functions or changing units requires changing weights. As a rule, the weight ratios change inversely proportional to the change of the unit. If a range decrease, for example, enlarges the unit of a utility function by 20% the weight ratios between this utility function and others should be 20% smaller. In other words, a change in the total utility range should result in a proportional change of the (non-renormalized) revised weight. Of course, after renormalization, all weights will change.

More formally, assume that model (1) is an appropriate

evaluation model, with properly constructed and scaled weights w_i and single attribute utility functions u_i . Further, assume that in one attribute, say x_1 , a change in range occurs. For illustration, Figure 1 shows a range decrease of an attribute both at its upper and lower end. Restandardizing leads to a revised utility function u_1' . How should the weights w_i change to weights w_i' ?

Since both u_1 and u_1' preserve utility difference judgments, the following equation must hold for any two attribute levels x_1 and y_1 , for which both u_1 and u_1' are defined:

$$u_1(x_1) - u_1(y_1) = T[u_1'(x_1) - u_1'(y_1)] \quad (2)$$

Multiplying both sides with the original weight w_1 gives

$$w_1[u_1(x_1) - u_1(y_1)] = (Tw_1)[u_1'(x_1) - u_1'(y_1)] \quad (3)$$

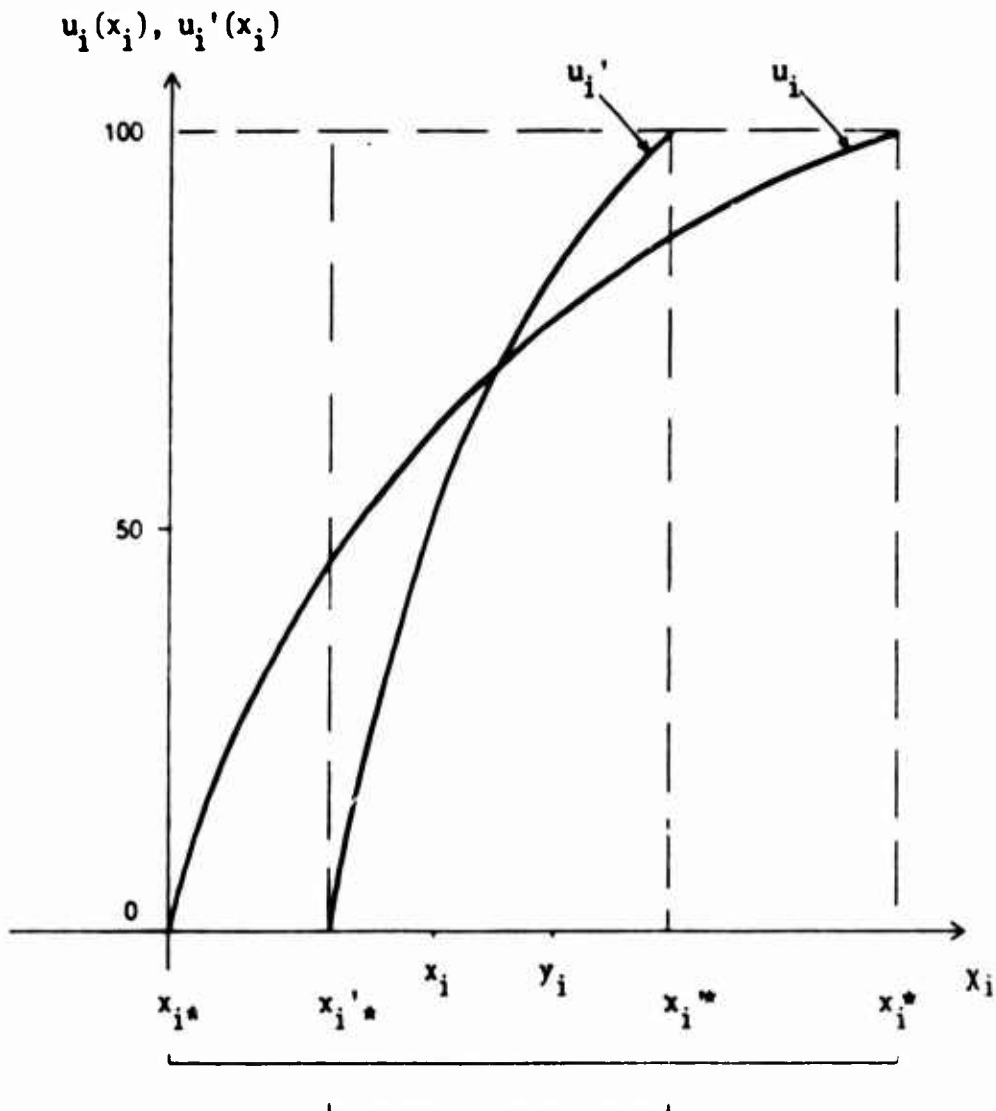
Before the range change $\frac{w_1}{w_i}$ matched a utility unit in u_1 against a utility unit in any other attribute i . As (3) shows T matches a utility unit in u_1 against a utility unit of the changed utility function u_1' . Consequently $\frac{Tw_1}{w_i}$ matches a utility unit in u_1' against a utility unit in any other attribute i . Algebraic manipulation of (2) gives:

$$T = \frac{u_1(x_1) - u_1(y_1)}{u_1'(x_1) - u_1'(y_1)} \quad (4)$$

for any two points which u_1 and u_1' share. Consequently the non-normalized revised weight w_1'' should be

$$w_1'' = Tw_1. \quad (5)$$

Figure 1
 Illustration of a single attribute utility function for a long range (u_i) and for a reduced range (u_i')



Observing that by the original normalization of the w_i 's

$$1 - w_1 = \sum_{i=2}^n w_i, \quad (6)$$

the normalized revised weights w_i' follow as

$$w_1' = \frac{Tw_1}{Tw_1 + (1 - w_1)} \quad (7)$$

and

$$w_i' = \frac{w_i}{Tw_1 + (1 - w_1)}, \quad i > 1. \quad (8)$$

In general, a change of the range or units in all n utility functions changes the weights to

$$w_i' = \frac{\frac{T_i w_i}{n}}{\sum_{j=1}^n \frac{T_j w_j}{n}} \quad (9)$$

This normative revision of weights gives rise to three observations. First, T should be smaller than 1 if the range decreases, and larger than 1 if it increases. In fact, T gives the factor by which a utility range decreases or increases relative to the original utility range. Second, the change in the non-normalized weight w_1'' and consequently in the revised weight ratios w_1''/w_i is proportional to T . Finally, the normalized revised weights w_i' do not change in proportion to T .

Otway and Edwards (1977) used equation (9) to recalculate weights in a nuclear waste disposal evaluation problem. In that application experts assessed weights based on ranges which were often substantially larger than those of the actual sites to be evaluated. Since single

attribute utility functions u_j were linear, equation (9) was the obvious candidate to compute normatively correct transformations of the weights assessed by the experts. As an alternative the experts could have reassessed their own weights based on the smaller ranges. Would that reassessment agree with the normative rule? This question is addressed in the following experiment.

EXPERIMENT 1

Method

Subjects. Twenty-four undergraduate psychology students at the University of Southern California participated as subjects. All of them received experimental credit which they used in partial fulfillment of their introductory psychology course requirements. Participants signed up on a first come basis.

Stimuli. A car evaluation example introduced subjects to multi-attribute evaluation problems and to the SMART procedure. Stimuli were 5 cars described on six dimensions as in Table 1. Test stimuli were 5 apartments described on six attributes and 5 sites for Liquefied Natural Gas (LNG) plants also described on six attributes (see Tables 2 and 3). In the test tasks one attribute range was variable. The changed attribute values are given in parenthesis in Tables 2-3. In the automobile and the apartment evaluation problem subjects had to make judgments according to their own preferences. In the LNG plant siting problem subjects had to consider the preferences of a governmental decision maker responsible for selecting a proper site.

Procedure. Subjects received written instructions to use the SMART

TABLE 1
Stimuli for the Car Evaluation Example

		CARS				
		A	B	C	D	E
A	Gas mileage (average miles per gallon)	10	20	30	40	50
T	Price (in thousands of dollars)	5	4.5	6.2	7.0	3.5
R	Rear knee room (in inches)	15	14	12	20	19
I	Impact speed that the front end will withstand leaving the passenger compartment intact (in miles per hour)	35	40	37	39	29
T	Trunk size (in cubic feet)	9	12	20	16	19
E	Interior noise (in dbA at 50 mph)	70	74	76	75	74
S						

TABLE 2
Stimuli for the Apartment Evaluation
Problem (In Brackets: Short Range)

		SITES				
		A	B	C	D	E
A T T R I B U T E S	Break-ins per year [*]	20	15	10	5	0
		(15)	(10)	(5)	(1)	(0)
	Rental fee in constant dollars	200	325	150	210	305
	Miles to work	15	25	23	7	10
	Age of complex in years	10	5	0	20	28
	Number of bedrooms	2	1	2	1	0 ^{**}
	Number of complexes in area	2	9	1	2	20

^{*} in neighborhood

^{**} studio apartment

TABLE 3
Stimuli for the LNG Plant Siting
Problem (In Brackets: Short Range)

		SITES				
A		A	B	C	D	E
T	Environmental damage in millions of dollars	0	4	8	12	16
T		(0)	(4)	(6)	(8)	(12)
R	Economic impact in millions of dollars	80	90	100	70	60
I	Miles to port	5	7	3	0	9
B	Years of operation	20	10	30	40	50
U	Number of faults	6	7	5	9	8
T	Population density in people per square mile	100	75	125	50	25
E						
S						

procedure. The instructions included a detailed example of an automobile evaluation problem. The subjects examined Table 1 and then saw how attribute levels could be rescaled based on the value levels for each automobile on each attribute. The five automobiles were rank ordered according to their levels on the attribute in question. After setting the best value of each attribute equal to 100 and the worst equal to 0, subjects then learned how intermediate levels can be set to correspond to their relative value judgments.

The use of the SMART procedure provided training for the subjects in the assignment of importance weights. Subjects saw how the six attributes can be rank ordered by importance with the arbitrary assignment of 10 to the least important dimension. Weights for the other dimensions are then assigned as multiples of the least important dimension. Subjects were clearly instructed to take ranges into account when making relative importance judgments:

"Forexample, you might consider 'trunk size' to be five times as important as (the least important dimension) 'interior noise' (value = 10). In this case you would assign the value 50 (5 times 10) to the factor 'trunk size.' By assigning a weight of 50 to one attribute (as in the case of 'trunk size') you are saying that a certain reduction (say 10%) in the location measures (utility) for the attribute is equivalent to 5 times 10 or 50% reduction in the location measures for the attribute with the weight of 10. In other words, the relative magnitude of the numbers reflect how a 10% reduction of the worth (the location measure) of the values in one attribute compares with the same reduction on the other attributes. For instance, the weight 50 on the

attribute "trunk size" means that losing 10% on trunk size is five times as bad as losing 10% on interior noise. You may re-examine your ranking in light of this consideration."

Based on this example of assessing utility functions and importance weights, subjects applied SMART to the apartment and the LNG siting problems. After completing both problems subjects saw essentially the same problems again, but this time the range in the first attribute ("number of break-ins" in the apartment example; "environmental damage" in the LNG example) was changed. The order of the problems (LNG vs. apartments) and the type of range change (increase vs. decrease) was varied according to Table 4. Subjects were randomly assigned to one of the four conditions in this table.

When repeating the SMART procedure subjects did not need to reassess utility functions for the unchanged attributes. Therefore subjects were presented with the original alternative by attribute matrices in Tables 2 and 3 with only the first attribute levels changed. They also were presented with an alternative by attribute matrix of their original utility measures with only the first attribute measures missing. Subjects reassigned utilities for that first attribute in both the apartment and the LNG siting problems. Subjects then reassigned all weights according to the SMART procedure.

Results

Of the 24 subjects, four could not follow instructions and their data were disregarded. The remaining 20 subjects provided as basic

TABLE 4
Experimental Conditions

Condition	First Problem	Range Change	Number of Subjects
1	LNG Plant	Increase	6
2	LNG Plant	Decrease	6
3	Apartment	Increase	6
4	Apartment	Decrease	6

data original and revised weights and single attribute utility functions in the two evaluation problems. To compute the expected weight change according to equation (5) three overlapping points of the original and the revised utility functions in the first attribute were used together with the cornerpoint which both utility functions shared. In the range decrease condition T was computed as the average

$$T = \frac{1}{3} \sum_{j=1}^3 \frac{100 - u_1(y_{1j})}{100 - u_1'(y_{1j})} \quad (8)$$

In the range increase condition T was computed as

$$T = \frac{1}{3} \sum_{j=1}^3 \frac{100 - u_1'(y_{1j})}{100 - u_1(y_{1j})} \quad (9)$$

where y_{1j} denotes the three points that the two utility functions share, x_1 of equation (4) is in all cases the common point of both utility functions at which they attain the maximum value of 100, i.e.,

$$u_1(x_1) = u_1'(x_1) = 100. \quad (10)$$

Table 5 presents the original normalized weights, the revised re-normalized weights and the expected re-normalized weights for the apartment and LNG problems and for the range increase and the range decrease separately. The normatively revised weights typically increase or decrease between .01 and .05 (or about 5-15%) as compared to the original weights. Actual weight changes are smaller and show no pattern of increases or decreases as predicted from the change in range.

TABLE 5

Original weight (w_1), revised weight (w_1^*), and expected weight (w_1')
 as a result of a change in the range of the first attribute
 (all weights are re-normalized to add to 1)

RANGE INCREASE

LNG PROBLEM (Conditions 1 and 3)

Subject	Original weight w_1	Revised weight w_1^*	Expected weight w_1'	Direction of change
1	.278	.267	.328	wrong
9	.278	.250	.329	wrong
13	.293	.281	.344	wrong
17	.286	.263	.354	wrong
21	.270	.227	.426	wrong
3	.056	.056	.088	none
7	.189	.206	.229	right
11	.200	.273	.234	right
15	.264	.273	.369	right
19	.070	.133	.059 ^{**}	right

In the number indicated by ^{**} the shape of the reassessed utility function strongly deviated from the original utility function, and expected weights based on formulas (8) and (9) were in the wrong direction.

TABLE 5 (continued)

RANGE INCREASE

APARTMENT PROBLEM (Conditions 1 and 3)

Subject	Original weight w_1	Revised weight w_1^*	Expected weight w_1'	Direction of change
1	.189	.205	.293	right
9	.217	.242	.268	right
13	.310	.295	.390	wrong
17	.260	.257	.426	wrong
21	.229	.235	.402	right
3	.205	.159	.232	wrong
7	.028	.028	.028	none
11	.185	.196	.236	right
15	.221	.243	.361	right
19	.214	.222	.303	right

TABLE 5 (continued)

RANGE DECREASE

LNG PROBLEM (Conditions 2 and 4)

Subject	Original weight w_1	Revised weight w_1^*	Expected weight w_1'	Direction of change
2	.277	.284	.234	wrong
6	.212	.257	.157	wrong
10	.258	.266	.240	wrong
14	.225	.220	.144	right
18	.337	.440	.289	wrong
22	.221	.227	.185	wrong
8	.329	.281	.246	right
12	.313	.313	.309	none
20	.234	.224	.197	right
24	.250	.239	.207	right

TABLE 5 (continued)

RANGE DECREASE

APARTMENT PROBLEM (Conditions 2 and 4)

Subject	Original weight w_1	Revised weight w_1^*	Expected weight w_1'	Direction of change
2	.258	.262	.230	wrong
6	.313	.313	.340 ^{**}	none
10	.219	.226	.158	wrong
14	.297	.233	.282	right
18	.329	.392	.283	wrong
22	.271	.271	.207	none
8	.264	.250	.193	right
12	.353	.313	.352	right
20	.288	.262	.173	right
24	.258	.254	.225	right

In the number indicated by ^{**} the shape of the reassessed utility function strongly deviated from the original utility function, and expected weights based on formulas (8) and (9) were in the wrong direction.

Apparently subjects were not even ordinally correct in their reassessment of weights. Table 6 presents a simple summary of the data in Table 5 to analyze whether subjects changed their weights in the right direction after a decrease or an increase in the range of attribute levels. For the LNG problem subjects were more often wrong than right (in 12 cases out of 20). In the apartment problem subjects fared a little better but still 9 responses out of 20 were in the wrong direction. Overall subjects were not sensitive to the range changes.

A more detailed analysis shows that of those subjects which changed their weights in the correct direction, most subjects (83%) did not sufficiently adjust. Only two responses were in the right direction but were of too great a magnitude. Only a single response out of 40 was correct!

How does this apparent range insensitivity and the subsequent misassessment of revised weights translate into actual utility orderings? The maxima of utility theory are very flat (see, for example, v. Winterfeldt and Edwards, 1973) which means that modest errors in changing numbers are unlikely to affect orderings. In only 3 out of 40 cases did the use of subjectively revised weights lead to a "best" option different from the best option using normatively revised weights.

Discussion

The results of the first experiment strongly suggest that subjects could not intuitively appreciate the effect a change in range should have on the importance weight for an attribute. Correct directions of weight changes occurred almost as often as incorrect

TABLE 6

Summary of Weight Change as a Function of a Change in the Range

LNG PROBLEM

		Weight should		Correct changes
		increase	decrease	
Weight Did	increase	4	5	
	stay same	1	1	40%
	decrease	5	4	

APARTMENT PROBLEM

		Weight should		Correct changes
		increase	decrease	
Weight Did	increase	6	3	
	stay same	1	2	55%
	decrease	3	5	

BOTH PROBLEMS

		Weight should		Correct changes
		increase	decrease	
Weight Did	increase	10	8	
	stay same	2	3	48%
	decrease	8	9	

ones. Most of the correct changes were too small. However, the normatively required changes were not sufficiently different from the (incorrectly) revised ones to produce different decisions.

There are several reasons why subjects' weight estimates may have been range insensitive. One reason obviously is that the expected weight change itself was not strong enough (typically less than 20%) to produce the desired effect. Revisions may therefore reflect random reassessment error due to the neglect of a relatively small required change. Another reason is that the task may have been too complex to produce the desired range effect. Both arguments call for a strong manipulation of the task variables (attributes and ranges). The second experiment was designed to magnify necessary range effects in a very simplified multiattribute evaluation problem. In this experiment utilities and original weights were prespecified as those of the "experimenter," leaving the subject with the sole task of revising weights.

EXPERIMENT 2

Method

Subjects. 69 students participated in this second experiment. Again subjects were psychology undergraduates from the University of Southern California. Participation rules were the same as in the first experiment.

Stimuli. Stimuli were three cars described on two attributes, "gas mileage" and "weight." Subjects saw them in the form of a car by attribute matrix as in Table 7. The range of the mileage attribute was changed by multiplying all numbers by 2 (the changed attribute levels are given in brackets).

TABLE 7

Stimuli for the Car Evaluation Problem in Experiment 2

(In Brackets: Changed Values for Range Change)

A T T R I B U T E S	CARS		
	A	B	C
Gas mileage (miles/gallon)	30 (60)	20 (40)	10 (20)
Weight (pounds)	2000	1500	2500

Procedure. Subjects were introduced to the ideas of the SMART technique, and were presented with the "experimenter's" single dimensional utilities. They were further told that the "experimenter" considered gas mileage as twice as important as weight, given the range of mileage available, thus giving a normalized weight of .667 to mileage and one of .333 to weight. 34 subjects then received the following instructions:

"Now suppose that someone discovered a way to double gas mileage so that the values for cars A, B, and C, are now 60, 40, and 20. For me, the rescaled values (location measures) will be as they were before, 100, 50, 0 respectively. What should my importance numbers (relative weights) now be? Should they remain at .667 and .333 or should they change? If they should change, what should they change to? Change? (yes or no) _____
If yes, to what? (mileage) _____ and (weight) _____ respectively."

35 subjects received slightly different instructions which required a change in weights and stressed ratio assessment:

"Now suppose that someone discovered a way to double gas mileage so that the values for cars A, B, and C are now 60, 40, and 20. For me, the rescaled values will be as they were before, 100, 50, and 0 respectively. But now these numbers refer to different actual gas mileages than they did before. Presumably, this has not changed my feeling about the importance of any specific gas mileage as compared with a specific weight. If so, then I should change the numbers that represent the importance of gas mileage to allow for the changed mileage aspects of the new set

of cars. Should I increase or decrease the importance of gas mileage? _____ Instead of 2/1 ratio of mileage importance to weight importance, what ratio should I use? _____ What should the importance numbers be if they should sum to 1? _____ & _____."

Results

Table 8 summarizes the results of experiment 2. In the first instruction group 24 subjects indicated that there should be no change in weights, clearly an error. Of the remaining 10 subjects, 8 answered in the correct direction. One answered in the wrong direction. One did not indicate what the change should be. Of the eight that responded with the correct direction, five gave exactly the correct answer; one erred in not renormalizing the weights; and the remaining two subjects gave slightly underestimated responses.

In the second instruction group thirteen of the 35 subjects were unable to give importance weights which summed to one. No analysis of their responses is appropriate. Although the response format did not permit this, two subjects indicated that there should be no change in weights. Of the remaining 21 subjects two-thirds believed that the change should be in the wrong direction, and one-third gave responses in the correct direction. But only one of the subjects gave the correct response, while the rest were conservative.

Discussion

Even in an absurdly simple problem subjects apparently had problems appreciating the sensitivity of importance weights to a change

TABLE B

Summary of Experiment 2: Changes in Weight as a Function
of a Range Increase and Instructions

	Instruction group 1 (normalized weights)	Instruction group 2 (ratio weights) Forced Choice
Exactly Correct Response	5	1
Correct Direction But Not Sufficient	3	6
No Change	24	2
Wrong Direction	1	14
Not Analyzed	1	13
Total	34	36

in the range of an attribute. In the first set of instructions 70% of the subjects felt that no change in the weights should take place. This supports the results of the first experiment which used more complex stimuli. The insufficient adjustment effect of the first experiment did not occur under these instructions, probably because the problem was so simple.

The second set of instructions seems to have confused subjects. Perhaps the words "presumably this (change in the gas mileage levels) has not changed my feelings about the importance of any specific gas mileage as compared to a specific weight" were confusing. In general, the results of this instruction group also support the hypothesis that subjects are range insensitive when revising importance weights, with only 7 subjects responding in the right direction.

Both experiments show that subjects did not revise weights after a change in the range of an attribute as would be predicted by the normative rule. The data suggest that subjects instead were rather insensitive to the change in range.

The meaning of importance as a relatively range insensitive attribute characteristic may have distracted subjects from properly considering ranges in their weight assessment. "Importance" is a relatively unexplored psychological concept. Several uses of the word indicate, however, that it is a rather stable property of attributes, which is carried over from one situation (and one range) to another. If no alternatives are specified people can usually give a

ranking of attributes in order of importance. In fact, such a range independent assessment was originally suggested in Edwards (1972). The fact that people can give importance orderings without specified alternatives and ranges may mean that they have some plausible set of alternatives and ranges in mind, when judging importance. According to this interpretation the importance judgments should only change when the environment radically changes the plausible set of alternatives.

If importance is in fact relatively stable across situations, the experimental instructions may have induced two opposing reactions in the subjects: on one hand their intuitive appreciation of the concept of "importance" would suggest no change, while the explicit range effect instructions required change. These opposing trends may have confused subjects, as the high rate of obviously incongruent answers suggests. An obvious manipulation to test this hypothesis is to leave out the label "importance" altogether, e.g., by asking "how much more would you like to step from the worst level in attribute 1 to the best as compared to stepping from the worst in attribute 2 to the best?"

The results of these experiments should be interpreted with much caution. If this experiment had shown that subjects are range sensitive in their weight assessment, a major problem in applying the SMART technique would have been solved. One problem for SMART suggested by the experimental results is that instructions which couple importance judgments with ranges in attribute levels can be

confusing. SMART procedures with swing weight techniques should consequently be done very carefully. The hypothesis that "importance" is a range insensitive concept poses a major problem to the SMART procedure. But it also offers two alternative

solutions: In the first, the term importance would be given up altogether and substituted by cross attribute relative value or indifference judgments as in Keeney and Raiffa (1976). In the second, importance judgments would be made independently of ranges and ranges would be defined to cover a "plausible" set of alternatives rather than the available set.

While the first solution is simple, and is easily implemented with only minor rewording of the weighting procedure, the second solution requires a quite different view of the multiattribute utility modeling problem. If, in fact, "importance" is a judgment which has substantive meaning and can numerically be scaled independently of its interpretation as a rescaling factor, incorporating importance could give additional substance to a multiattribute evaluation model. This argument is not unlike the argument for using external judgments of probabilities as independent inputs into an expected utility model (as opposed to the interpretation of probabilities as prices or rates). The problem, of course, remains, how to standardize single attribute utility functions in such substantive uses of importance judgments. This is clearly an experimental question.

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17. ABSTRACT (Continue on reverse side if necessary and identify by block number) Scaling factors in multiattribute utility measurement can either be assessed directly as importance weights or indirectly by indifference judgments. Critics of the importance weight interpretation of scaling factors argue that importance weights are not sensitive to ranges of alternatives and thus cannot be used to match standardized single attribute utility functions. To examine the range sensitivity of importance weight judgments two experiments were designed. In the first experiment college students gave relative		

importance weight judgments for a number of attributes when evaluating apartments and liquified natural gas plant locations. After the initial importance weight assessments the range of alternatives in one attribute was changed and subjects reassessed their weights. Although subjects were explicitly instructed to take ranges into account when making these judgments, they were unable to adjust their weights appropriately. To magnify possible range effects a second experiment examined a very simple two attribute car evaluation problem. Subjects were asked directly if weights should change after the range in one attribute was doubled. Most subjects indicated that there should be no change. The results of these experiments suggest that subjects have plausible ranges in mind when assessing importance weights and that they are unwilling to change weights after relatively spurious changes in the alternative set.